dinner is open to every one, not merely to members of the Association, at $1.00 per person. Those intending to be present are requested to notify Professor George Depue Hadzsits, College Hall, University of Pennsylvania, by May 2, at the latest. Admission will be by ticket only. Tickets will be issued on receipt of subscription price.

On Saturday, at 12.30, luncheon will be served in the Drexel Institute, at 60 cents per person. Those intending to be present should notify Professor Hadzsits, by Friday evening, May 3, at the latest, enclosing subscription price. C. K.

SOME ASPECTS OF THE DOCTRINE OF EVOLUTION ANCIENT AND MODERN

Evolution has been defined as a natural history of the cosmos, including organic beings, expressed in physical terms as a mechanical process. From very early times one phase or another of the doctrine of evolution as it has become known to us has been hit upon by writers and thinkers. Thales, Anaximander, Anaximenes each posited a substrate from which all things are sprung and into which all things return. The early Pythagoreans reached much farther in their teaching. On the basis of their mysterious number theory they built the structure of the cosmos. All beginnings, they said, depended upon unity, which, when once obtained, becomes the active agent in setting in orderly array the unformed chaos outside this unity. In their cosmology the first unit formed was the sun. This then became the active agent in the formation of the earth, the moon, and the other heavenly bodies out to the place where chaos still reigns. They even provided for an unlimited continuation of this process. Their destined universe is still in the making. Heraclitus based all things on fire and flux, Empedocles upon permanent but composite elements. The latter's theory of adaptations reminds us of Darwin, and his theory of emanations and pores as means of sensation corresponds to the modern theory of absorption.

The Stoics also, in a sense, were evolutionists. There was first, they said, an original being both material and spiritual. The former was fire, the latter deity. The world-process was, they thought, a self-realization of the divine Being. The divine Spirit permeates the *all*, and, therefore, seeds beget individual things. The individual souls of men arise from the all-pervading world-soul (this from Heraclitus). The present world, they believed, was one of a series; the end of all is to be burned, and all things are finally resolved into primordial substance.

But Leucippus and his followers came the nearest of any of the ancients to a statement of that phase of the doctrine of evolution which is known as atomism. The early school posited an infinite store of eternal atoms in motion, from which combined and recombined the present order has sprung. This is the beginning of the doctrine of atoms, and on its physical side is the forerunner of the nebular hypothesis. The other great source for the doctrine of evolution in antiquity is Aristotle. He believed in a transcendent deity expressing himself in the moving, acting world. His theory of sense-perception resembles that of Herbert Spencer. He thought that νοῦς made its way into man from without. In his Politics he elaborates a process of civic development based on the principle of the necessities of society. Aristotle is the great biologist of antiquity.

We may take, then, Leucippus, and his followers, on the physical side, and Aristotle, and his followers, on the biological side, as the thinkers of antiquity who most of all set forth systems of philosophy embodying a doctrine of evolution. For the modern theory we are indebted to Laplace, Kirchhoff, Darwin, Spencer, Mendel, and others.

Let us consider briefly the principles of the ancient and the modern theories of evolution, trace their resemblances and their differences, and draw what conclusions we may from the study. We may consider, then, these theories as they have been applied to (1) the world, (2) life, (3) man, (4) human intelligence, and human speech, (5) human society, law and government, (6) the moral and religious sense in man. Only the first three of these can be treated here.

The ancient atomistic view of the evolution of the world is as follows. An infinite store of atoms moving in infinite space for an infinite time has begotten the present order and all past orders of things, and will beget all orders of things yet to be. As to shape, the atoms are of few varieties, three or four, but the number of atoms of each shape is infinite. As to composition, the atom is of solid singleness, unchangeable, everlasting, and, as far as actual separation goes, indivisible. Theoretically, however, the atom is divisible, since it is composed of several least parts, which, put together in a variety of ways, would yield the few varieties of atom shapes, round, angular, hooked. These atoms ever falling in space but swerving slightly from the perpendicular course clash, whirl, and form aggregations, which in themselves acquire the motion of their constituent atoms. Thus from atoms the worlds are formed—the sun, the moon, the stars of heaven, and into atoms these worlds and all things else shall be resolved.

The modern theory of the evolution of the universe, chiefly concerned, of course, with our own solar system and our planet, is set forth in the nebular hypothesis, that nebulous masses of heated matter at first filled all space. This nebula, according to Laplace, had a movement of rotation on an axis. This rotary motion may be explained on the ground that in contracting toward the center as it cooled the matter on both sides of the mass would not preserve the same density, and a consequent rotary motion would result. This rotary motion would increase as contraction by cobling continued. So rings and balls of matter would become detached, preserving the motion of their parent mass and developing like rotary motion. In later times it is generally

accepted that the spiral nebulae, e. g. *canes venatici*, which of late have been found to be very numerous in space, are probably the best illustration of the transfo mation which originally went on when our own solar system was in the process of making. Herschel collected data which go to show that the sun of our solar system was once an immense nebula filling space at least as vast in extent as is the orbit of Neptune, that it gradually condensed and partially solidified, leaving portions of its substance in the form of planets, moons, etc., and so on down to its present shape and size. The heat of the present sun, also, is kept up, it has been supposed, by the transformation of energy resulting from the continued contraction of its diameter in the process of cooling.

The comparison of the ancient and the modern theories on the matter of the origin of the universe shows that in principle advancement has been made along the line that was most to be expected. The nebular theory as to cosmic substance is in no way essentially different from that of Democritus, Epicurus, and Lucretius. There seems to be more advance in the matter of motion and heat in the heavenly bodies, and in the discovery by Kirchhoff of the identity of certain substances like sodium, lithium, strontium, etc., in the earth and in the heavenly bodies[1]. But, if we examine carefully the early Pythagorean doctrine, as well as the doctrines of Democritus and Epicurus, we shall see that the principal addition of modern times is the discovery of the spiral nebulae which serve now as an illustration of the possible cosmic process through which our solar system has passed. Yet, with all the observed phenomena, it cannot be said that any nebula has been caught transforming itself into a system like our solar system. All that can be said is that this nebula and that, and a multitude of others have been photographed in such positions and conditions that the composite of these impressions might convey some idea of how the cosmic process in our universe may have gone on.

The present-day triumphs of atomistic physics are truly great[2]. It is now possible to count the number of atoms and molecules in a given mass of matter with as much accuracy as the census of any community can be taken. It has been shown that the atom contains electrical constituents and these also have an atomic structure. In this way a theory of electricity has been superimposed upon the atomic theory of matter. It has also been shown that every electric charge is composed of an exact number of electrical atoms, and that every electrical current consists in some kind of transmission of these electrical atoms through some medium. The exact value of this elementary electric atom has been measured and established. It has also been shown that every molecule, of whatever size, in a gas at a given temperature is endowed with precisely the same average kinetic energy, and this universal constant has been measured. Furthermore, even the tracks of the alpha and the beta corpuscles have been photographed as they shoot out from radioactive atoms with something of the velocity of light. But at this point we are reminded of the unsettled condition in which atomistic physics finds itself. There are no less than five theories urged as the solution of the nature of this elemental atom. After reviewing the investigations of the more recent years certain physicists conclude (1) that neither atoms nor electrons appear to be able to absorb any energy until it comes to them in a certain degree of intensity, and this degree varies with different substances; (2) that, when energy results in the emission of electrons, there is apparently a complete, or nearly complete, inter-convertibility of energy between an electron and a so-called ether ray, whether it be an X-ray or a light ray. There is, they say, no good reason why the ether may not be found to be of such a structure as to permit of a localization of radiant energy in space, or of its emission in multiples of something, if necessary, without violating the laws of interference.

Yet the positive transformation of one element into another, or the constitution of matter out of energy, is still not an accomplished fact. Many things point toward the performing of this miracle of science. We can only wait while investigators assiduously carry forward the search. It may be accomplsihed at any time, and it may never be accomplished. It is interesting here to note that Lucretius's theoretically divisible atom has been shown to be actually made up of constituent parts.

Aristotle's theory of the origin of life is quite modern. He believed that nature is two-fold, form and matter, that chance and fortune are secondary to intellect, and that necessity is the cause behind things. Adaptive structures, he thought, were not produced on the principle of the survival of the fittest, nor yet by chance, but by necessity. Germs, not animals, he said, were the first to be produced and the soft mass which first subsisted was the germ. He also believed in a sequence of purposive productions.

The ancient atomists held that all forms of life are composed of lifeless, senseless atoms. Proof of this, they said, is to be seen everywhere. Living worms spring out of dead refuse when the earth is putrid with heavy rains. Streams of water, leaves, and glad pastures are transformed into cattle, and these again nourish the human body, and the bodies of men often are food, i. e. life to powerful beasts and birds. This transformation of inert, lifeless substance into life and sense is, they said, much the same as the process by which nature converts dry fuel into flame. But no life at all is begotten until a proper union and arrangement of atoms with other atoms takes place, so that these atoms impart and receive life-giving, sense-giving

[1]This is clear from spectrum analysis. The Frauenhofer lines in the spectrum of the sun correspond to the bright lines of the spectra of various gaseous substances. This shows that the dark lines of the solar spectrum are caused by the fact that the light of gaseous substances in the photosphere of the sun strains out the light of the same gases in the nucleus of the sun.

[2]For these statements see R. A. Millikan, Science, New Series 37 (January 24, 1913).

motions. In the days of her youth also the earth brought forth all kinds of herbage, flowers, shrubs, and trees. For, just as feathers, hairs, and bristles are first born on birds and beasts, so the new earth put forth grass and bushes, and then gave birth to various races of mortal creatures. And none of these forms could have dropped from heaven to the earth nor could those on land have come from the salt pools. Even now many living things spring out of the earth, induced by the rain and the sun's heat. Many races too of living things must have been born and have passed away ere this. Every living breathing race has been protected and preserved by craft, by courage, or by speed. Witness the fox, the lion, and the stag. Creatures useful to man have survived because in return for the service they can render man they share his protection against their more vicious rivals. Those to which nature has granted none of these qualities, whether in a state of wild nature or in a state of domestication, would fall a prey to their betters and by nature would be utterly extinguished.

The reason why Lucretius did not accept Aristotle's findings in the matter of a law of gradual development in organic life but rather turned back to the earlier philosophers is not far to seek. The purely mechanical view of the universe is the one above all others which Lucretius must establish. There must be no design, or possibility of design, no divine intervention of creation or immanence in nature. Such design is certainly taught by Aristotle. Hence Lucretius turns away to the purely mechanical theory of the universe with original atom motion as the moving force and chance for the directing cause, and that too even to the including of all animal life.

The modern ideas of the evolution of organic forms concern themselves with the theory that forms of life traced back to a lowly and primeval origin show the likelihood of widely dispersed protoplasm composed chiefly of a living cell or cells of which all organic bodies are composed. This substance is to modern science the physical and material basis of all life. It was not, however, until 1861 that Max Schultze[3] established the identity of Dujardin's (1835) sarcode and von Mohl's (1846) protoplasm. This viscid, semifluid substance possesses the property of motion, as seen in the amoeba and in the white corpuscles in the blood. It possesses the power of assimilating foreign substances, of building itself up by this means, and of decomposing the resultant molecules into simpler ones. The development of species of animate forms was worked out by Darwin on the following principles: variability under domestication, variability under nature, the struggle for existence, and natural selection. The whole work is a scientific investigation of the ancient theory of survival.

[3]Schultze showed that in the lower forms and in the higher forms of life as well the living substance is one and the same substance, protoplasm; that in plants this substance, although usually bounded by a cell-wall, is sometimes without a cell-wall or membrane, and that in many unicellular forms and in many animal tissues the cell membrane is always absent. His conclusion therefore was that the cell-membrane is not essential in any case.

In comparing the ancient and the modern views on the origin of life we are reminded that the doctrine of spontaneous generation was universally believed until after the middle of the seventeenth century. In fact, this doctrine was first shown to be unsound by Redi, the Italian investigator, in 1668. In 1683, van Leeuwenhoek discovered bacteria, and showed that the ordinary processes of sterilization were not effective. But it was not until the discovery of Pasteur (Studies 1866–1876) that abiogenesis on a microscopic scale was found to be as impossible as it is on a larger scale. The dictum *omne vivum e vivo*, all life from antecedent life, is proved for all known substances. It is still conjectured, and has been the fond hope of many an investigator, that some new substance may be discovered, or mayhap be produced in the laboratory, which shall prove that inorganic matter may be made to merge into organic matter by a process of artificial creation. But until such artificial creation is an established fact we must needs fall back on the ancient doctrine that life, living substance, organic matter, is nature, or on the other theory that it is the result of a special act of particular creation.

As to man's origin and development Aristotle is unmistakably evolutionary in his doctrine[4]. He finds the first indications of life even in inorganic nature. All motion, in a sense, may be regarded as life. But the highest manifestation of life is in man, the highest animal. And the lower forms of life often bear analogous parts to the highest forms, and there is a steady advance from the lower to the higher. The roots of things in the plant world serve the purpose of mouths for animals. Bloodless animals have certain humors, an organ which corresponds to a heart, and the semblance of a brain. Molluscs have cartilage where snakes and fishes have bones. Instead of lungs fishes have gills, and they breathe water instead of air. The wings of birds, the claws of crabs, the fore feet of quadrupeds and the arms of man are all analogous. Certain embryonic resemblances between man and the lower orders also exist. The habits, occupations, tempers, and reason of animals can be compared with the same qualities in man. The human soul in childhood can with difficulty be distinguished from that of the lower animals. In this way does an inner bond of union run through all organic forms. Organic nature, too, is the sphere of design, and here too the order of existence is reversed. Here man, the last in origin, is the first in value. From the highest sphere of heaven to the earth, nature displayed a constantly diminishing perfection. At the earth she reached a turning-point. For the elements as they combine make ready the proper conditions for the development of living creatures, and life is revealed from its first frail germ to its highest and finest form in man. So Aristotle.

[4]These statements are found chiefly in Aristotle's De Partibus Animalium and De Animalium Generatione. They have been commented upon by Zeller and others.

The ancient materialistic doctrine of the evolution of man, according to Lucretius, is as follows. Mother earth in the early days of her uncouth and unadorned appearance here and there developed wombs, which, fertilized by processes of nature, such as the falling of heavy showers of rain and the natural heat of her cosmic body, brought forth upon her bosom rude and savage men. Nay more, the very food of this primeval stock was nature's milk, constrained seasonably to flow for the sustenance of nascent man. Warmth of earth also was his raiment, and her bosom was his couch. No chilling winds nor scorching heat exacted upon these early sons of earth. So too came at the proper time all manner of wild beasts and fowls of the air. Monsters too in early days the earth brought forth, prodigies neither male nor female, creatures without feet, devoid of hands, dumb, blind, and halt. But nature set a ban on these, in that they could not well combine and so beget their kind. But, because some limit of producing must be set, mother earth, full of days and worn with age, ceased to bring forth.

Here again the reason why Lucretius did not adopt Aristotle's findings as to the origin and development of man is found in the fact that the former could in no wise brook the latter's doctrine of design in the universe.

The modern theory that man is descended from some less highly organized form is based on the following observations: (1) embryonic similarities, (2) numerous common points of structure and constitution, (3) the retention in man of rudiments of structural elements belonging to lower orders, (4) abnormal reversions to which man is occasionally liable. The mutual affinities of members of the same group, their geographical distribution, and their geological succession seem to show the same. It has been claimed that variations in the physical structure of man are induced by and obey the same general laws as is the case with the lower orders. It is said that there is the same struggle for existence, and that the same laws of inheritance, and the same laws of natural and sexual selection prevail in man as in the lower species of animals. Man's progenitors were once hair-covered, bearded creatures, with pointed movable ears, and provided with a tail; their feet were prehensile, and the males had great canine teeth; they were arboreal and lived in a warm climate. At an earlier stage these progenitors were aquatic; our lungs are modified swimming-bladders, and the clefts in our necks show that we once possessed branchiae. The heart was once a single pulsating vessel. Through numerous minute variations accumulated by inheritance through countless generations man and all animal forms below him are traceable to a few original types. This is the Darwinian theory of the evolution of man, and for practically fifty years it had acceptance with the great majority of scientists and investigators of every rank.

Two assumptions were based on the theory of numerous minute variations propagated by inheritance, namely, that variation was a continuous process, and that any variation could be transmitted to offspring. Both of these assumptions are now found, on Mendel's law, to be unjustified. Two sorts of variation seem to be proved by Mendel beyond controversy, namely, those variations which are due to specific characters in the organism, and those which are due to the direct effect of the environment during the lifetime of the organism. The former are known as mutations, the latter as fluctuations. The former are inherited, since they represent characters embodied in the gametes of the species, but the latter are not known to be inherited. What appear to be transmissions of individual characters arising from environment are amply explained on other grounds. No change in the species will occur, then, unless there be some change in the gametes, the germ cells which unite to form a new individual. And these changes are not the result of a long series of minute characteristics transmitted through many generations. They are abrupt, sharp, and clearly defined. Intermediates in any species are not commonly produced. The true criterion of what constitutes a species is sterility, and that particular form of sterility which prevents two healthy gametes when united from producing a new individual (zygote) with normal powers of growth and reproduction.

A comparison of the ancient and modern views of the origin of species culminating in man shows almost as much difference among modern scientists as there was among ancient thinkers, and in either case almost as much as between the ancient and the modern views. Aristotle is not measurably farther from Epicurus than Darwin is from Mendel. Aristotle and Darwin, and Mendel perhaps even more all leave the universe open to design in structure and process.

It little becomes us in modern times to minimize in any way the great discoveries of science which have revealed to us the vastness and grandeur of our universe, or to decry the splendid work of investigators who have told us the truth about the massive measures of our solar system and the microscopic marvels of things animate and inanimate about us. But it is equally unbecoming to fail to see or to refuse to admit the great and masterful work of the men of old as constructive thinkers. We may be as far removed from the final truth about many things, nay even about many of the same things, as were the sages of antiquity. To be sure we are in possession of facts unknown to them. But mere facts, petty facts, never yet of themselves have produced any great system of thought, no gigantic sweep of the intellect to bring man to a higher and a better understanding of the universe and his relation to that universe. It is perfectly conceivable that a single intellect might compass all present knowable facts about the movements and processes of the universe and still not know the universe greatly better than did Pythagoras or Aristotle. Doubtless the ancients often thought they had arrived at finality in their theories, but we know how far they were from the goal. The same is true of us. The tale of all possible human

knowledge will never be told. Were one to master the accumulated knowledge of all the ages, yet would one not be certain that he had absolute and final knowledge of any person or of any thing. So varied and infinite is nature in all her ways.

One object of this study has been to try to show that every age must make its own contribution to the sum total of human knowledge and understanding, and that the serious contribution made by any age must be considered by succeeding ages as a serious and valuable effort, and not a contribution to be held up to scorn and cited as an example of impotence. The ancients are entitled to a serious and sympathetic consideration from us such as we should desire for ourselves in the minds of the ages yet to come.

WASHINGTON AND JEFFERSON COLLEGE. ROBERT B. ENGLISH.

REVIEWS

"Know Thyself" in Greek and Latin Literature. By Eliza Gregory Wilkins. Private Edition. Distributed by The University of Chicago Libraries (1917). 106 pages.

This University of Chicago dissertation appears in a scholarly and methodical form. It has a Table of Contents; a short Preface, in which the writer explains the aim of her study, and acknowledges her indebtedness to Professor Shorey; ten chapters, dealing with the various phases of the theme (1–99); a list of passages in Greek and in Latin authors, cited in chronological order for each language, first the passages in which there is an explicit reference to the maxim—either by exact quotation of the words or by other unmistakable language—, and, secondly, the passages in which the reference is "apparent, though more or less indirectly expressed"; and a Bibliography, evidently of only the most important works, however (105–106).

The various chapters have these headings:

I, Introduction (1–11); II, "Know Thyself"[1] as Know your Measure (12–22); III, "Know Thyself" as Know what you Can and Cannot Do (23–32); IV, "Know Thyself" as Know your Place. Its Relation to ΣΩΦΡΟΣΥΝΗ (33–40); V, "Know Thyself" as Know the Limits of your Wisdom (41–45); VI, "Know Thyself" as Know your own Faults (46–51); VII, "Know Thyself" as Know you are Human and Mortal (52–59); VIII, "Know Thyself" as Know your own Soul (60–77); IX, "Know Thyself" is Difficult; How Attained (78–88); X, "Know Thyself" in Early Ecclesiastical Literature (89–99).

After looking at these headings, or, surely, after a slight consideration of the subject, a critic will probably find two queries coming to his mind: (1) Will there not, in the nature of things, be a different connotation of the words of this maxim in the mind of the physicist and of the philosopher, of the laity and of the priesthood, of the pagan and of the Christian?; (2) and—what might seem almost contradictory to the view just expressed—is it possible to pigeon-hole, so exactly as is implied by the chapter headings, the meaning of the maxim in each particular passage?

Chapter I, containing the Introduction, is concerned with the various apophthegms of the Seven Sages, as they appeared on the Delphic temple. The writer, however, does not here follow the wisest plan, in the judgment of the reviewer. She should either have confined herself to her narrower subject, "Know Thyself", or have treated all the maxims. As a fact, however, she gives a brief glance at the others, but, before dwelling on her special maxim, focuses her gaze for a bit on the meaning of the puzzle *E*. Apparently she feels the inconsistency of her position, for she says (2), in what seems almost an apology for her treatment of this particular saying,

> Modern discussion of the inscriptions at Delphi is concerned chiefly with the meaning of the *E* and with the arrangement of the sayings. . . .

She gives the various solutions that have been offered with regard to this puzzle. As to the date of the appearance of these sayings at Delphi, the writer does not express herself decisively. She says (6)

> they must have been on the temple built toward the end of the 6th, or early in the 5th, century to replace the old stone structure destroyed by fire in 548 B. C., and it is possible, if not probable, that they were on the earlier temple of stone.

She comes to no conclusion as to whether, as Roscher believes, the sayings "originated at Delphi and had only a local application" or were inscribed at Delphi after they had been formulated. After referring to Roscher's theory, she says (8),

> But the ancient theory that they appeared at Delphi only after they had become current proverbs is at least equally plausible.

The last part of the Introduction is concerned with showing the extent to which the particular maxim, "Know Thyself", was discussed in ancient times and the comparatively small number of long discussions that have survived to our day, though the shorter discussions and the references are so numerous.

In Chapter II, Miss Wilkins begins to discuss the separate passages in which the maxim occurs. It is found first in a fragment attributed to Heracleitus (Stobaeus, Florilegium 5.119). However, it is in Aeschylus, Prometheus 309–310, that we find the first example of its use where the context gives the meaning. Oceanus is giving advice to Prometheus. Of this passage the writer says (13):

> Obviously Oceanus' plea is that Prometheus may humble his pride and adopt manners becoming a subject god. To know himself is to know his place as subject of the new king, to recognize his limitations in his inability to defy Zeus save to his own hurt. And these meanings of *γνῶθι σαυτόν*, together with the more general idea of knowing the measure of one's capacity, were undoubtedly the usual connotations of the maxim, as we shall see from our further study.

[1] In the dissertation we have each time, in the chapter-title, the Greek words.